EXERCISE 1

An experimental team identified the following factors to be important with regard to the shrinkage of parts from an injection molding process:

A. Mold temperature
B. Pressure
C. Cycle Time
D. Screw Speed

Find a two-level design which will accommodate these factors and which will allow the following interactions to be investigated:

AxB
BxD

EXERCISE 2

Find a two-level design whch will accommodate

Factors A, B, C, D, E, F, G, H and I, and
Interactions AxB, AxC, BxC, BxD

EXERCISE 3

Find a two-level design whch will accommodate

Factors A, B, C, D, E, F, G, H and I, and
Interactions AxB, AxC, AxE, AxF, BxD

THREE-LEVEL DESIGNS

If we wish to vary all the factors in our experiment over three levels, we can use one of the three-level designs found in Appendix A.

EXAMPLE 2

Consider again the four factors in Example 1:

A. Raw Materials
B. Annealing Methods
C. Temperature
D. Treating Times

Suppose the experimenters wanted to test these factors over three levels (instead of two) and no interactions were expected. Then an L_9 orthogonal array (shown in Table 3) could be used.

TABLE 3
L_9 ORTHOGONAL ARRAY

No. \ Column	1	2	3	4
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1
Groups	1	2		

The L_9 array may also be used for an experiment involving two three-level factors and their interaction. Figure 3 contains the only linear graph for the L_9 array. Notice that the line segment is labeled with two columns: 3 and 4. This tells us that we need to use columns 3 and 4 for estimating the interaction between the two factors, say A and B, which were put in columns 1 and 2 (see Table 4).

Why are two columns needed to estimate the AxB interaction? It has to do with the required degrees of freedom. The degrees of freedom for a factor is one less than the number of levels. The degrees of freedom (df) for AxB is

df for A x df for B.

Since A and B are three-level factors, they each have two degrees of freedom. So,

df for A x B = 2 x 2 = 4.

Thus, 4 degrees of freedom are needed to estimate AxB. Each column of the L_9 array has 2 degrees of freedom associated with it (since they are three-level columns). Two columns gives 4 df, which is the required amount for the specified interaction.

FIGURE 3
LINEAR GRAPH FOR L_9 ARRAY

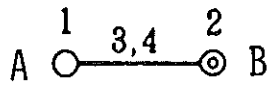

TABLE 4
L_9 ARRAY FOR TWO FACTORS AND THEIR INTERACTION

No. \ Column	A	B	A X B	
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1
Groups	1	2		

EXERCISE 4

Find a three-level design which will accommodate the following factors and interactions:

A, B, C, D, E, F,

AxB, AxC, BxC.

EXERCISE 5

Find a three-level design which will accommodate the following factors and interactions:

A, B, C, D, E, F, G

BxC, BxD, BxE.